

Animals are life cycles

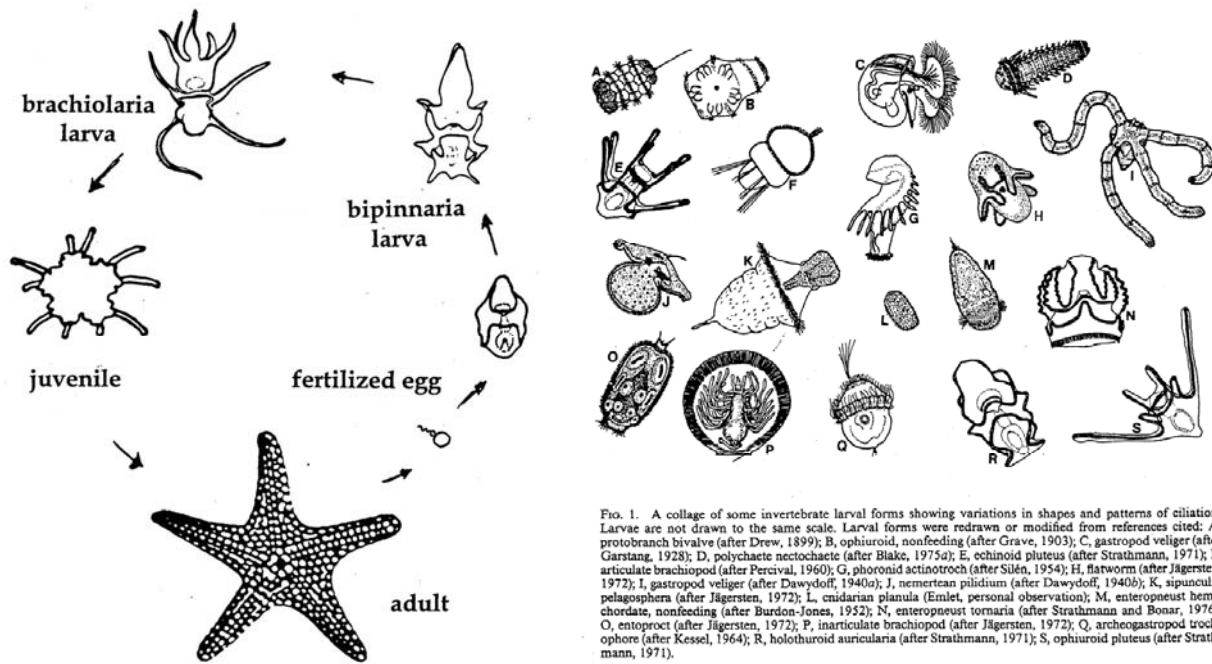


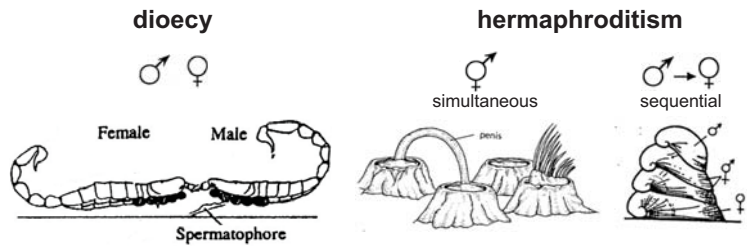
FIG. 1. A collage of some invertebrate larval forms showing variations in shapes and patterns of ciliation. Larvae are not drawn to the same scale. Larval forms were redrawn or modified from references cited: A, protobranch bivalve (after Drew, 1899); B, ophiuroid, nonfeeding (after Grave, 1903); C, gastropod veliger (after Garstang, 1928); D, polychaete nectochaete (after Blake, 1975a); E, echinoid pluteus (after Strathmann, 1971); F, articulate brachiopod (after Percival, 1960); G, phoronid actinotroch (after Silén, 1954); H, flatworm (after Jägersten, 1972); I, gastropod veliger (after Dawydoff, 1940a); J, nemertean pilidium (after Dawydoff, 1940b); K, sipunculid pelagosphera (after Jägersten, 1972); L, cnidarian planula (Emlet, personal observation); M, enteropneust hemichordate, nonfeeding (after Burdon-Jones, 1952); N, enteropneust tornaria (after Strathmann and Bonar, 1976); O, entoproct (after Jägersten, 1972); P, inarticulate brachiopod (after Jägersten, 1972); Q, archeogastropod trochophore (after Kessel, 1964); R, holothuroid auricularia (after Strathmann, 1971); S, ophiuroid pluteus (after Strathmann, 1971).

Modes of Sexual Reproduction

	Sexes ¹	Broadcast Spawn?	Brood? ²
Porifera	d, H		+++
Cnidaria	D, h		+++
Ctenophora	d, H		+
Platyhelminthes	d, H	C	+
Nemertea	D, h		+
Nematoda	D, h	C	++
Annel. Polychaeta	D, h		++
Sipuncula	D, h		+
Mollusca	D, H	C ⁴	++
Arthro. Crustacea	D, H	C	+++
Hexapoda	D, h	C	+++
Phoronida	d, H		++
Bryozoa	d, H		+++
Brachiopoda	D, h		++
Echinod.	D, h		++
Hemichordata	D		-
Urochordata	D, h		++

¹ Sexes: D = dioecious, H = hermaphrodite, lower case = rare.
² Brooding: embryo development encapsulated or on adult body.
³ Typically or often only male spawns.
⁴ C = copulation (or other direct gamete exchange)
⁵ All cephalopods, most gastropods.

Modes of sexuality



Modes of fertilization

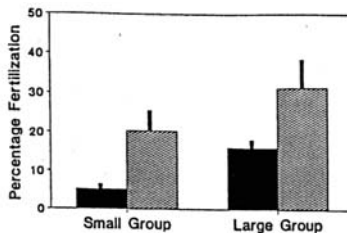
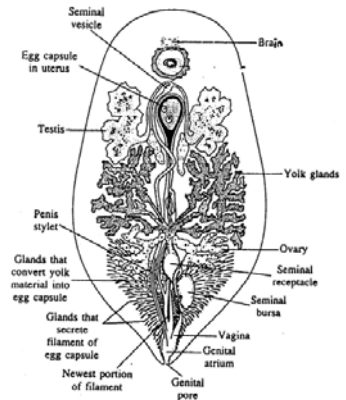


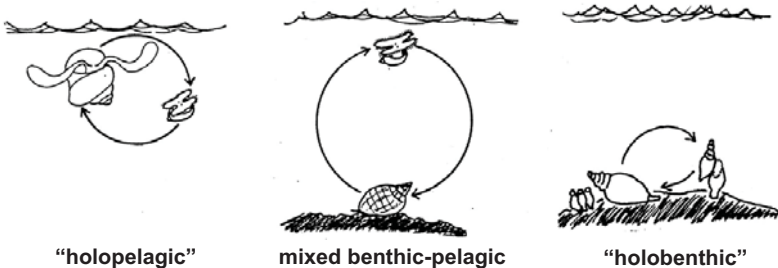
FIG. 4. Percentage of eggs fertilized as a function of spawning-group size and degree of aggregation. Solid bars are dispersed treatments; hatched bars are aggregated treatments.

Broadcast spawning

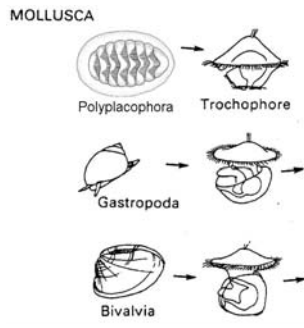
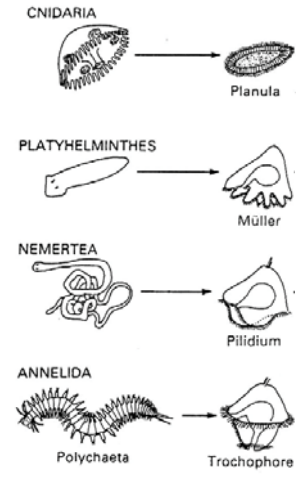
Insemination



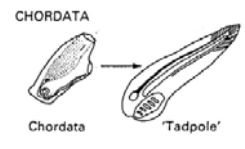
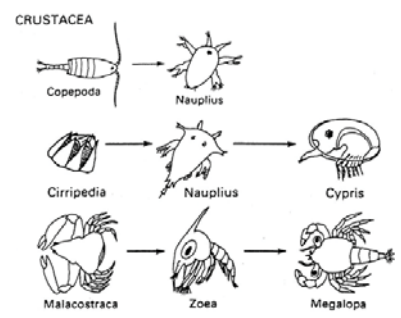
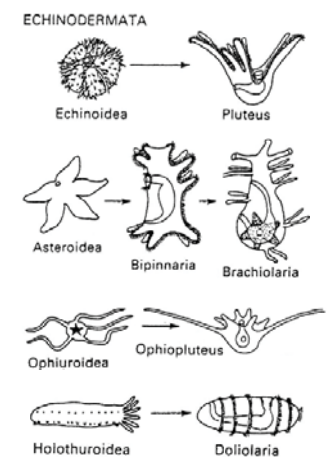
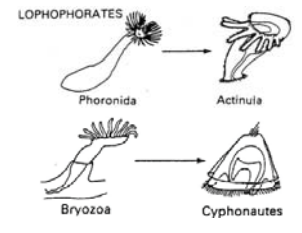
Modes of habitat use



Presence of metamorphosis and typical larval forms

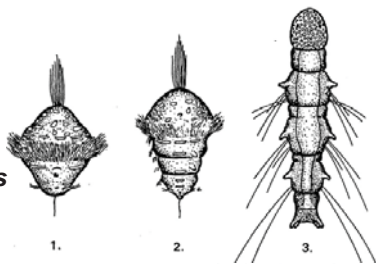


	Metamorphosis?	Typical larva
Porifera	Yes	amphiblastula
Cnidaria	Yes	planula
Ctenophora	Yes	cydippid
Platyhelminthes	Yes	Müller's, cercariae
Nemertea	Yes	pilidium
Nematoda	No	
Nematomorpha	Yes	gordioid
Acanthocephala	Yes	acanthor
Rotifera	Yes	
Annel. Polychaeta	Yes	trochophore
Sipuncula	Yes	trochophore
Mollusca	Yes	trochophore, veliger
Arthro. Crustacea	Yes	nauplius, zoea
Hexapoda	Yes	caterpillar, grub, maggot
Phoronida	Yes	actinotrocha
Bryozoa	Yes	cyphonautes, coronate
Brachiopoda	Yes	articulate larva
Kamptozoa	Yes	
Echinod. Oph, Ech	Yes	pluteus
Ast, Hol	Yes	bipinnaria, auricularia
Hemichordata	Yes	tomaria
Urochordata	Yes	tadpole
<i>Chaetognatha</i>	No	
<i>Onychophora</i>	No	
<i>Gastrotricha</i>	No	
<i>Kinorhyncha</i>	No	
<i>Loricifera</i>	No	Yes
<i>Tardigrada</i>	No	Yes
<i>Priapulida</i>	No	Yes
		<i>Higgins</i>
		<i>Lorica</i>

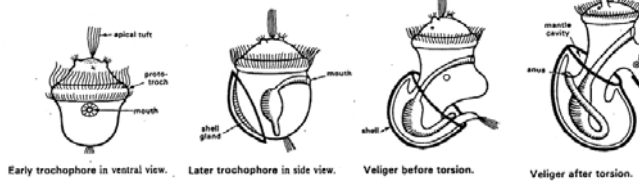


Some examples of metamorphosis

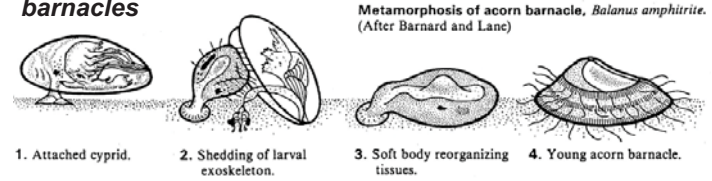
polychaetes



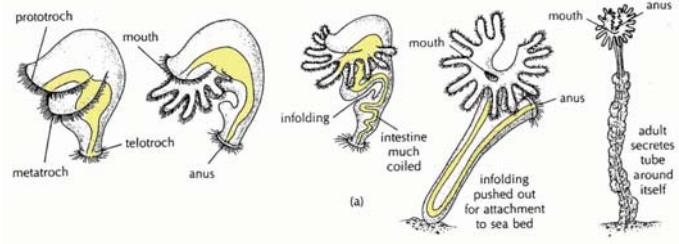
gastropods



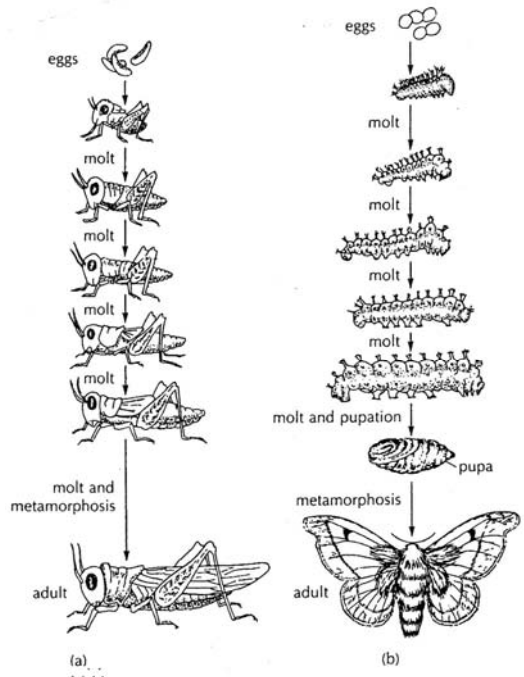
barnacles



phoronids



Direct and indirect development in terrestrial insects

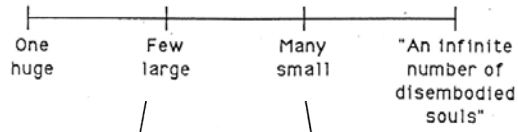


(a) Hemimetabolous development of a grasshopper.
 (b) Holometabolous development in the silkworm moth.

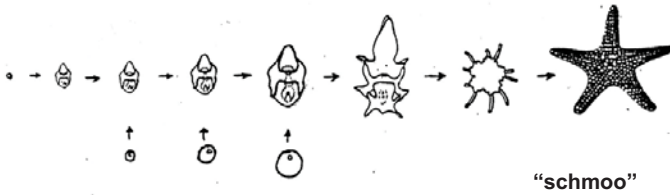
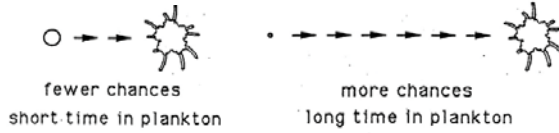
Life-history evolution of marine invertebrates

the "time-fecundity model"

tradeoff:
egg size vs.
egg number

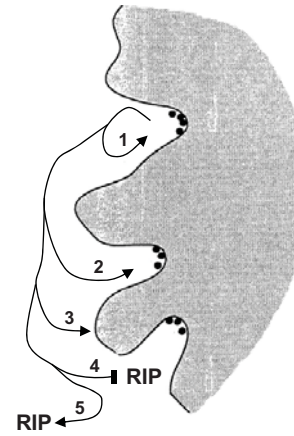


life-history
strategies



consequences of investment in
different egg sizes

Risks of time in
the plankton



Consequences for egg
size evolution of:

- Food supply?
- Predation risk?
- Offshore currents?